

INTERIM PAPER

‘Product Design for an On-board Check-In System on the Tyne and Wear Metro for Passengers Travelling to Newcastle International Airport’



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1 INTRODUCTION

With the ever growing problem surrounding the increasing congestion on the roads and carbon emissions, new ways to travel are being investigated which are more efficient, environmentally friendly and economical. Metro railway services are a viable solution to this problem, however, the public still take a preference to travelling by automotive vehicles and it is therefore the aim to encourage people to utilise the metro services more frequently by offering a genuine incentive.

The Tyne and Wear Metro is a light railway which serves a large population of the North East. The metro has a station located at Newcastle International Airport, however, the vehicle is poorly equipped to facilitate passengers travelling to the airport with luggage. This in turn results in passengers opting to travel by taxi or car as the impracticality of carrying luggage on-board the metro is too great.

To help improve the utilisation of the Tyne and Wear Metro, particularly those travelling to Newcastle International Airport, this study has looked into the potential of offering passengers a solution to the inconvenience of carrying luggage on-board the metro by investigating into implementing an on-board check-in system on the current Tyne and Wear Metro vehicles. The main focus of this study will be the interior product design of facilitating such an idea, however, this interim report will be focussing on the current research and literature obtained before then discussing the methodology to be conducted in completing this study and a brief summary in the current work completed and the direction in which the study is heading.

2 LITERATURE REVIEW

2.1 MOTIVATION

In this present time, new options for transport are being investigated to help suppress the increasing production of carbon emissions through excessive use of petrol and diesel powered vehicles. In 2015, car traffic grew by 1.1% from 2014, setting a new record since 2007 [1]. This continuous increase in car traffic is presenting issues surrounding high concentration of carbon emissions, particularly with in city centres, whilst also creating major congestion on the roads. Travelling on the road is becoming extremely unreliable due to the unpredictability surrounding the journey time, due to excessive traffic, when travelling to a particular destination. A mode of transport which provides solutions to these issues is electric powered trains and metro vehicles. Whilst road users account for 71% of transport carbon emissions, railway companies account for less than 1.8% [2]. Railway vehicles are able to contain several passengers into one single journey, during which the vehicle produces a negligible amount of carbon, and so removes vehicles from the road and in turn helps in the reduction of carbon emissions and congestion. Particularly during peak times of travel, many commuters resort to travelling by rail out of choice. Rail provides an extremely reliable service as the trains are efficiently organised to operate so that traffic is non-existent and therefore actual journey times are assured and consistent to the time of travel expected therefore making them suitable modes of transport when punctuality is vital.

The Tyne and Wear Metro provides a rail service for an expansive population in the North East of the United Kingdom, with stations located in Newcastle upon Tyne, Sunderland, North Shields and Newcastle International Airport. Following the opening of the Tyne and Wear Metro in 1980, further extensions were made to the line in 1991 where the service was extended to Newcastle International Airport [3]. Despite this, full utilisation of this facility was not conducted. Since the beginning of the

Tyne and Wear Metro operations, a decline in passenger flows has been observed whilst the metro scores are amongst the lowest in terms of operated passenger capacity in relation to network size [4]. Increasing the number of passengers that use the Tyne and Wear Metro would help in the aim to reduce both carbon emissions and congestion on the roads. A suitable way to do this is by encouraging passengers to use the metro when travelling to and from the airport. It is thought that whilst the current metro provides a service to Newcastle International Airport, the operations and interior design of the airport metro cars are not suitable for those passengers travelling with luggage and this therefore deters people from using this service and instead resorting to automotive transport.

Travelling to the airport can be a stressful and expensive experience. For most people, the preferred mode of transport when travelling to the airport is automotive through the use of a car or a taxi. This is particularly typical for those passengers travelling with luggage. The ability to travel hands free is the main reason for the preference to travel by car or taxi due to the fact large suitcases can be stored in the boot of the vehicle. Issues arise however in the cost of these modes of transport. Travelling by car means resorting to paying for the long stay car park facility provided by most airports. In the case of Newcastle International Airport, using such a facility can cost in excess of £80 per week. Travelling by taxi can also have extremely high costs, particularly for those that live far away from the airport. In the case of someone living in Sunderland, a return taxi journey to Newcastle International Airport can exceed £100. It is in the interest of those passengers travelling to the airport to avoid these unwanted costs and therefore look for more affordable options. The Tyne and Wear Metro provides a suitable mode of transport for people travelling to the airport as it is both cheap and reliable. Despite this, the use of the metro is avoided due to the inconvenience of having to carry large luggage on a public transport service which provides no storage and has an interior layout which is inadequate in accommodating passengers travelling with suitcases. Travelling to Newcastle International Airport via the City Centre can be risky due to excessive congestion, particularly during peak times of rush hour, and therefore a more reliable service is that of the metro, however, the potential for an overcrowded metro is another factor in discouraging passengers to use this facility as boarding the metro with a baggage can be impractical, particularly in the case of a family with several suitcases or a passenger with luggage of a greater size such as a set of skis.

2.2 EXISTING SOLUTIONS

Attempts have been made to help resolve the issues raised in the motivation for this study. This section of the report looks at some existing systems and facilities which are in place to help encourage the use of public transport and discusses the advantages and disadvantages which can be applied to help in obtaining a viable solution for this study.

2.2.1 Virgin Bag Magic

Virgin Bag Magic is a service introduced by Virgin Trains. From £31.67, a courier can collect a passenger's suitcase from their house and deliver it to any UK destination. This therefore removes the need for passengers to have to carry a heavy suitcase with them when using their railway service. This can make for a more pleasant travel and peace of mind in that passengers do not have to store their luggage on board the train where it is out of view. By using this facility, passengers can leave their house, travel by public transport and arrive at their destination without their suitcase. This offers the added benefit for more opportunities such as upon arrival heading straight out into town for a meal or to a business meeting without the need to drop off any luggage at the hotel initially. Such a system could be adapted to the Tyne and Wear Metro to help encourage passengers to use the metro service as it tackles the issue by removing the luggage from their person.

Whilst this service seems an adequate solution to the issues raised, it does have some major setbacks. In the case of people travelling unexpectedly last minute, this service would not be available as suitcases would be required to be collected from the person's home one day in advance. There is a disutility associated with passengers having to pack their luggage early and therefore this makes this service unsuitable [5]. Another issue is the unavailability to utilise this service when travelling abroad. For those passengers that are flying to a destination outside of the UK, this service is not available and is currently therefore extremely limited in terms of its global availability. Finally, the most important issue with this facility is the cost. With this system costing over £30, this can in some instances be a similar price to that of the train tickets and therefore result in a 100% increase in the cost of the journey therefore making the Bag Magic facility not such a prudent choice. In a study conducted by Daniel Reece, Virgin Bag Magic was seen as a facility which would be utilised far greater providing the costing was reduced or even free [5].

2.2.2 InPost

Inpost is a service in which people can send a parcel and have it delivered to one of many national global lockers positioned across Europe. A postage stamp can be printed online and attached to the parcel before either being handed to the courier or by placing the parcel in one of the available lockers. The parcel is then transported to the required destination in which it is then stored in a locker, ready for the recipient to collect. The use of this facility can be related to that of a baggage handling system. Passengers travelling to destinations abroad can use the facility to post items to a location near to their hotel to therefore remove or reduce the number of items they are to carry and thus allow them to travel light [6].

The InPost service works similar to that of Virgin Bag Magic however it has the added benefit of the delivered item being able to be collected at an InPost locker at any time. Issues arise though in that the maximum dimensions for the parcel are limited at 38cm x 38cm x 60cm which makes for a small suitcase. Such a facility can therefore not be used for large heavy luggage which are the main issue when it comes to the impracticality of carrying luggage on public transport. Furthermore, when posting abroad, the minimum number of days to deliver is on average 6 days which would require advance preparation in sending an item. As stated in Daniel Reece's study of Virgin Bag Magic, such a system which requires early packaging is not approved by most passengers and therefore the InPost service would be highly impractical.

2.2.3 Hong Kong in town check-in

Several baggage handling services have been erected in different cities across the world in the attempt to encourage people to use public transport when travelling to the airport. A system like this is the Hong Kong in town check-in. Passengers are able to check in their luggage in the city centre before then being able to travel hands free for the remainder of the day leading up to the departure of the flight. The luggage that has been checked in is then transported as freight via a separate train which carries the luggage to the airport to be loaded onto the aircraft. Passengers can then spend the day exploring the city and then continue to the airport without luggage and proceed straight through to security thus avoiding excessive queues to check in bags. This facility offers a great incentive to use public transport as it allows for minimum time required to be spent travelling to the airport and inside the airport whilst also allowing passengers the freedom to travel without baggage. Whilst people, particularly those with a higher income, may have insisted on using a taxi or car to travel to the airport, they are now given a reason to use public transport as it provides benefits which taxis and cars cannot offer. By encouraging more people to travel by public transport, the stress of being stuck in traffic against a ticking clock and the heavy cost of parking fees and taxi fares are removed whilst also removing the physically demanding task of manoeuvring bags through turnstiles, up and down stairs

and between crowds of fellow passengers [7]. Furthermore, this facility costs just \$13 U.S which is cheaper than other forms to transport.

Initial downfalls with this facility is the issue in that passengers are required to travel to the city centre with their luggage. This would therefore cause passengers to travel part of the journey with a form of luggage hence the inconvenience of having to carry a suitcase on public transport has not been completely removed. There is also the potential for lost time in that passengers would have to depart the public transport service at the city centre to check in their bags when in fact it may be quicker to travel directly to the airport. For people that are located closer to the airport than that of the city centre station, there also remains the issue in some passengers may find that they would have to travel in the opposite direction from the airport in order to check in their bags which again contributes to lost time.

2.2.4 Baggage Collection Hub at Haymarket Station

A study was conducted at Newcastle University in which a baggage collection system was modelled to observe whether such a system, similar to that of the Hong Kong in town check-in facility, could be implemented with the Tyne and Wear Metro. The idea was that a baggage collection hub would be located in the Haymarket metro station [8] in which passengers could check in and drop off their luggage before proceeding to Newcastle International Airport.

When analysing this model, an estimate of just 24 passengers per year travelling from North Shields were calculated to use this facility out of a current metro ridership of 6000 [9]. This value is extremely low and shows a much lower utilisation of the facility than that estimated for Virgin Bag Magic or the Inpost service. The main reason for this low estimation of passengers was found as being due to the need for passengers travelling from North Shields to have to transfer metro at Monument station before then departing at the following station (Haymarket station) in order to check in their luggage. This is incredibly inconvenient for passengers as it accounts for wasted time in continuously having to depart the metro whilst also requiring to do this with heavy baggage. In this instance it therefore would seem more convenient to travel directly on the metro to the airport station to avoid having to maneuver luggage on and off the vehicle. Another issue as to the low utilisation of the facility by the passengers is the costing. The study found that when setting the cost to zero, the number of passengers that would use the baggage collection hub out of the 6000 metro riders increased by 113.4% [9]. This shows that there is a demand for such a system, however, it would require to be of a low price or deemed as physiologically free by including the price within the flight or metro ticket. This may be difficult however as such a facility would be extremely expensive with major works being required on the infrastructure of the metro such as at both Haymarket and the Airport station. Changes to the current signalling would have to take place whilst several new employees would be required which would have a major cost. With a small number of passengers estimated to use this facility, the price to use such a system would have to be considerably high in order to fund this study.

2.2.5 Melbourne Airport Monorail Interior Design

Whilst new external facilities which help remove any luggage from a passenger is beneficial in encouraging using public transport services, having an interior design on board the metro which is suitable for accommodating passengers carrying large bags is also fundamental. Currently the Tyne and Wear Metro is unsuitably designed for passengers travelling to the airport with luggage. The metro contains no storage on board and narrow walk ways, which make carrying luggage through the metro a daunting task. This in itself can be a major contribution as to why passengers would prefer to travel to the airport by taxi or car and therefore the interior design of the metro should be addressed.



Figure 1: Interior Design for the Proposed Melbourne Airport Monorail [10]

An example of where the interior design has been considered is in the proposal for a high-capacity automated monorail to Melbourne Airport, Australia [10]. The design produced for the internal layout of the monorail has considered a high capacity of passengers with baggage. The use of longitudinal seats have been implemented in the design which allows for open space making it easier to manoeuvre luggage through the vehicle and creates space in front of seated passengers making

it possible to place any luggage by their feet. Hanging straps and vertical rails have also been used to provide safety for passengers that are standing. This internal design would encourage people to use this rail service as a means of travelling to the airport and therefore these design features should be carried forward into the Tyne and Wear Metro.

Upgrading the internal design may not be enough however to see a significant increase in the utilisation of the Tyne and Wear Metro, when traveling to Newcastle International Airport, as there remains the inconvenience of having to carry a large suitcase in public. Furthermore, in the case of families with several suitcases or passengers with alternate luggage, such as a set of skis, using the metro would still remain an impractical mode of transport. It should therefore be considered to combine such a baggage collection facility with an upgraded internal design within the metro.

2.3 TYNE AND WEAR METRO

This section of the report is the research surrounding the current facilities and figures of the Tyne and Wear Metro and the plans for the future. The majority of the information has been acquired from a publication produced by Nexus into the metro strategy for 2030 [4].

2.3.1 Statistics

The main factors that influence the demand for the metro are the population, GVA (Gross Value Added), road fuel costs and impacts of congestion. Currently, the North East has a growing population with an increase in 2.2% from 2001 [11]. The GVA has seen a massive 90.8% increase in the North East since 1997 [12] whilst petrol has gone from 28.2p per litre since 1980 (when the metro operations began) to over 110p per litre [4] and congestion, as discussed earlier in the report, increasingly becoming an issue particularly in the city centre. Based on these facts there should be an increasing demand for the metro, however, the utilisation of the metro is not at its highest and therefore has the potential for a greater ridership. Further incentives should be made to encourage the use of the Tyne and Wear Metro which can be done by installing facilities for passengers travelling to the airport as to accommodate those carrying luggage.

In the document of the Metro Strategy for 2030, it states that there is a continued growth in passenger numbers forecasted by the airport operator with the number of passengers travelling to the airport being the highest growth in percentage terms. This increase in passengers proves that there is logic for an upgrade as to help accommodate those travelling to the airport. It is clear that people are already willing to use the service to travel to the airport, therefore incorporating more facilities to subsidise passengers travelling with baggage would greatly increase the ridership of the Airport metro.

Compared to other light rail services within Europe, the Tyne and Wear Metro has one of the highest seating densities. This does not complement the fact that in the Nexus study, most passengers travel on the metro for a total of 10 minutes and therefore don't necessarily require to be seated. This therefore shows the potential for removal of seats on board the metro as to accommodate passengers travelling to the airport with luggage. In the case of the Edinburgh Tram, the seat density was dropped to just 1.8 (compared to the Tyne and Wear Metro's of 2.3) as to accommodate for luggage storage space due to Airport traffic. This is something which should be highly considered for the Tyne and Wear Metro as doing so would encourage more people to use the metro service whilst also offering an increased capacity with more room for passengers to stand.

2.3.2 Future Improvements to the Metro Service

By 2030, Nexus is aiming to have produced major upgrades and modifications to the existing metro rail service currently in place. The regeneration process for the metro has been called 'The Metro Reinvigoration' programme which has been sectioned into three phases.

Phase one involved upgrades into the ticketing and gating programme surrounding the metro. This phase has been completed as of now. Meanwhile, Phase 2 is currently in process and aims to complete modifications into the track, building, systems and stations. Refurbishment of the tracks is being focussed around the city centre whilst refurbishment of 45 station is in process and upgrades in the communications and signalling systems are to be conducted. Due to this work already being underway, it may be difficult to begin to look at any baggage collection schemes in Newcastle city centre as such a system would require further upgrades to stations and signalling which would therefore be difficult to fund. Within Phase 2, a significant condition assessment has been conducted on all 90 of the metro cars which determines them suitable for continued operation into the 2020s. Following this, new considerations need to be made for new fleet and improved capacity.

Phase 3 of the programme involves renewal of the fleet. The aim for Nexus is to have new fleet operating by 2030 and it therefore seems appropriate for any new systems, related to passengers travelling to the airport, to be attempted to be installed coinciding with this major upgrade. Retrofitting of the currently existing metro cars is possible in this upgrade and therefore redesigning of the current vehicles could be considered as long as clear justification is observed from an increased passenger demand [4].

A new way of signalling the metro which is being considered by Nexus for the new fleet is that of a driverless metro. Currently the metro is a fully driver-operated vehicle with automatic train protection (GoA 1 as seen in Figure 2) in which emergency brakes are applied if a signal is passed at red. Some of the important factors which allow for good customer satisfaction on the metro are said to be reliability, punctuality, staff availability, train cleanliness and passenger behaviour. All these factors can be greatly improved by implementing a driverless service on the metro. The reliability and punctuality of the metro would improve as the metro would operate on a more precise time scale due to an improved headway from using a moving block and the automatic management of the vehicles. Meanwhile staff availability, train cleanliness and passenger behaviour are all improved because, due to there being no driver, a member of staff can be employed to assist in customer satisfaction for passengers travelling on the metro without any further expenses in the employment of extra staff. The staff member may also be able to manage the operation for any on board baggage facilities that could be installed on the metro.

Potential driverless grades of automation which are being investigated to be installed with the Tyne and Wear Metro are the GoA 3 semi-automatic driverless system and the GoA 4 unattended train operation as seen below in Figure 2.




Grade of Automation	Type of train operation	Setting train in motion	Stopping train	Door closure	Operation in event of Disruption
GoA 1 	ATP with driver	Driver	Driver	Driver	Driver
GoA 3 	Driverless	Automatic	Automatic	Train attendant	Train attendant
GoA 4 	UTO	Automatic	Automatic	Automatic	Automatic

Figure 2: A table showing the various grades of automation which could be implemented into the Tyne and Wear Metro [4].

The metro is made up of two services called the Green Line and the Yellow Line. The Green Line operates to the Newcastle International Airport station and it is on this line that there are issues in installing a driverless system due to the presence of pedestrian level crossings and the metro sharing the same line as Network Rail's Sunderland Line. Therefore, whilst installation of a driverless system could be incorporated, it would not be able to operate for the whole of the Green Line. It is thought that a GoA 3 system would only be able to operate for around one third of the line whilst a GoA 4 could operate for nearly two thirds of the line due to the potential to be able to overcome level crossings with this type of driverless system. Therefore it would seem sensible to consider this type of driverless system if such a facility were to be incorporated. This would allow the driver to manage any on board baggage facilities for the majority of the journey.

2.4 NEWCASTLE INTERNATIONAL AIRPORT

Newcastle International Airport is the largest airport in the North East. It operates out of a one terminal building and operates with 20 different airlines. Since 2010, the number of passengers that utilise the airport has grown from 4.34 million to 4.54 million per year [13]. This statistic also shows that there can be as many as 12,500 passengers per day using the airport which can contribute greatly to road traffic and therefore the need for an incentive for these passengers to use the metro service provided. This massive number of passengers shows that there should be a much greater number of passengers utilising the metro service than currently exists and therefore adapting the metro to accommodate passengers travelling to and from the airport would significantly increase the ridership and generate more money towards the facility. The increasing number of passengers shows that there also needs to be changes to the metro to facilitate for these passengers or else the service provided by the metro in travelling to the airport is not fully utilised and of a wasted potential.

2.5 STUDY BRIEFING

By observing the data collected in the literature review and investigating the benefits and limitations of the existing facilities, a new solution has been considered which is believed to solve the issues of poor utilisation of public transport when travelling to the airport whilst tackling the limitations of the existing solutions discussed. The solution is to investigate the potential of implementing an on board check-in system on the Tyne and Wear Metro for passengers travelling with luggage to Newcastle International Airport. Such a facility would allow passengers to check in their luggage upon boarding the metro and therefore enjoy the majority of the journey without any baggage. This study will

specifically be looking at the interior product design of the on board check-in facility and investigating how such a facility could be retrofitted into the existing Tyne and Wear metro cars. Observations can then be made as to the benefits and limitations of the system and whether it could work and thus be applied to the current Tyne and Wear Metro and other existing light rail services in the future. This on board check-in system would be the first of its kind.

This design idea offers many incentives which other modes of transport and existing facilities cannot provide. A great deal of time is saved due to the fact that the time taken to travel to the airport and check in luggage is combined hence making the time required for the mundane procedures, prior to the departure of the flight, being minimised. Any anxieties of excessive queues at the check in desks inside the airport are also removed as passengers that use the on board check-in facility are able to proceed straight through to security upon arrival and so offering an appealing incentive to passengers of all income.

The benefit, when compared to a baggage collection hub in the city centre, with having the baggage check-in facility on board the metro car is that there would be no need for any major regeneration of the infrastructure. The metro would remain as a two car service and operate in the same way and therefore not require changes to the current signalling in place whilst, other than some slight modernisations to the Airport station, no sufficient reconstruction of the stations would be needed. This would therefore allow for the installation of such a facility to be relatively low cost and for the service to be offered to passengers at a cheaper price. Furthermore, the on board check in service would allow passengers to instantly check in their baggage upon boarding any airport bound metro service hence removing the need to depart the metro to check in luggage and allowing passengers to travel most of the journey without a bag rather than having to wait until arriving in the city centre.

3 METHODOLOGY

The identification as to the requirements, characteristics, market research and facilities available for this study was conducted using a roadmapping technique. This provides a framework to help tackle the fundamental questions that apply to this study [14] thus clearly demonstrating the aims.

By observing the design and operations of the current Tyne and Wear Metro vehicles and researching into the existing facilities in place and technology available, the idea is to come up with a design for the interior of the Tyne and Wear Metro cars as so they can facilitate the on board check in system.

Various operations and interior layouts will be considered before then producing a selection of sketches displaying alternate designs of the interior of the metro cars. Following analysis of these designs, a final product will be selected to be modelled and analysed. This final design will be produced as a 3D model using Autodesk Inventor to give a digital prototype for the on board check-in system. This 3D digital prototype can then be used to give a clear and realistic visual of the setup of the metro. This can help in providing a reliable product which offers assurance in the functionality of the design idea. Following this, the operation, benefits and limitations of this design will be discussed before concluding as to whether such a design could be set up and even potentially applied to other light railway services around the world.

Validation of the product design is then hoped to be conducted from either simulation using equations produced from previous studies or by public perception. By doing this, it would provide further evidence as to whether such a facility would be utilised by the public and provide support in the conclusions for this study.

4 CURRENT WORK

Currently most of the research into the literature has been completed in order to develop design ideas for this study. At this present time, the development of the final design is in progress in which a suitable layout and way of operating an on board check-in facility is being analysed. This section will briefly look into the work completed around this area so far.

The Tyne and Wear Metro currently operates with two metro cars coupled together. This is due to most platforms being unable to accommodate for more than two cars. In order to keep costs down and the practicality of implementing such a system into the current Tyne and Wear Metro service up, it has been concluded that the design should attempt to avoid the potential for a third metro car and therefore be part of the current two car system. The aim is therefore to minimise the amount of change required to the metro cars so that the capacity of the vehicle is not heavily affected.

In terms of how the on board check-in facility will operated on the airport metro vehicles, each metro would serve a specific set of flights that are due to depart that day. Passengers can check online as to which metro serves their flight and then await for that specific metro. The idea would be that displayed on the front of the metro would be the flights in which passengers may use the facility to check in their luggage. This way, baggage can then be appropriately organised and transported to the correct flight operator once at the airport station. By observing the current interior plan of just one of these metro cars, the interior has been sectioned into four parts labelled as section A, B, C and D, as seen in Figure 3.

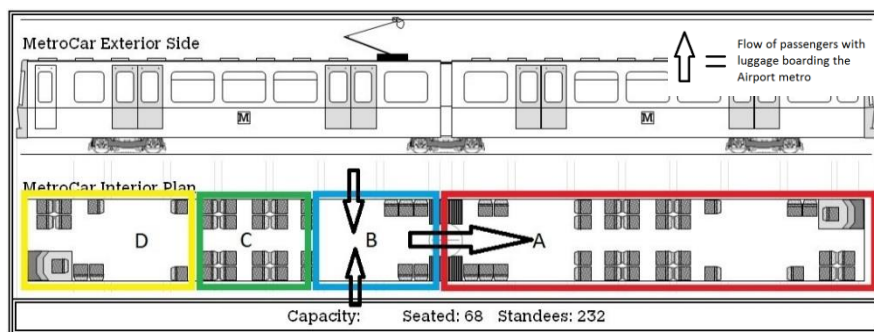


Figure 3: A diagram showing the current interior plan of one of the Tyne and Wear metro cars, split into sections A,B,C and D.

Passengers are required to wait for the metro which corresponds to their flight. Those passengers travelling with luggage would then board that metro at section B and collect a numbered ticket as they enter. These passengers are then required to stand, or be seated on the longitudinal seats seen in that section, and wait for their number to be displayed on what would be an LCD screen. Once a passenger's number is displayed, they would then be required to move to the check in desk/machine, obtain their boarding passes and hand over their luggage. Section A would be separated from section B by using a ticket barrier, similar to the ones used at the Tyne and Wear Metro stations, as to prevent passengers not travelling to the airport from crowding section B. Therefore, upon a passenger checking in their luggage, they would then receive a ticket to be used to access section A of the metro where they can then be seated without any baggage to have to consider.

In using this internal operation of the metro, it was then intended that a minimal amount of the metro would need to be regenerated whilst only one quarter of the current two car metro service would be facilitated by the new on board check-in system. Due to section A being utilised only by passengers without luggage, it is deemed that section A would not require any modifications. From observing

section B, it is also clear that no changes would be required to this section as it is already suitable for passengers boarding with luggage due to the presence of open space made by the utilisation of longitudinal seats. This existing layout makes it easy to manoeuvre baggage on the metro whilst the longitudinal seats allow for the ability to position luggage in front of the seat whilst waiting to check in. For this study, it has therefore been determined that the main focus will be the design within both sections C and D. The initial plan would be to remove all components from these sections such as the seats, handles and rails, apart from that of the driver's cabin, as to create a large open space in which new facilities can be installed such as check in machines/desks and containers in which the luggage can be stored. The main focus of section C will be to look into ways in which baggage can be checked in by using either a self-check-in machine or a staffed check-in desk depending on the grade of automation used to drive the metro. Current research suggests that just one staff member is preferred on board the Tyne and Wear Metro as to keep costs down and therefore an investigation needs to take place in comparing the designs for utilising a GoA 3 driverless system with a staffed check in desk or a GoA 1 driver operated system with a self-service baggage drop machine similar to the ones used by KLM at Schiphol Amsterdam Airport [15]. The focus in section D will then be to observe the ways in which this section can be used to store the luggage that has been checked in by using secure containers and how this luggage can be organised and operated to meet security and safety standards whilst having the ability to check in awkwardly sized alternate luggage. The metro car containing the check in facility would be the front car when travelling to the airport as section D has purposely been selected at the front end of the vehicle as to keep the luggage at the driver's side of the metro to provide assurance for the security of the baggage.

It is a health and safety requirement that there is a minimum of 6 operational doors per metro car. By considering this, a suitable way to operate the doors of the metro has been designed as to aid in the flow and safety of both the passengers and baggage. The doors at section D of the metro would remain closed at all times until the metro arrives at the airport station as to prevent the possibility of people being able to tamper with the checked in luggage. Once the metro arrives at the airport, the doors at section D would open and the containers containing the luggage can then be wheeled off to airport security by a staff member. The doors at section B of the metro would operate at all stations, however, only those passengers that want to check in luggage are allowed to access the metro using these doors. The doors at section A would then operate as usual and be available to all metro passengers.

By continuing to develop this design over the coming months, it is hoped that conclusions can be made as to the most suitable features and design ideas to use which can then be applied to the final product to be produced as a 3D model using Autodesk Inventor.

5 CONCLUSION

In conclusion, the work conducted so far is up to date with most research required to cover the topic completed. Current work towards designing a final product is successful with the aims of keeping the costs low and the space acquired by the baggage check in system on the metro to a minimum being achieved. Comparisons have been made with the existing solutions observed in the researched literature as to apply their beneficial factors into the study whilst, with this new facility, attempting to resolve the issues raised to create a system which betters the existing solutions and offers the public a great incentive to use public transport when travelling to the airport. As work continues, the final design can be analysed and a conclusion can be made as to the benefits and limitations of implementing an on board check-in system onto the Tyne and Wear Metro and whether such a facility would be both functional and feasible in applying it to other light railway services across the world.

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